Evaluation of the Tracy Fish Collection Facility Holding Tank Screen Entrainment Efficiency for Juvenile Delta Smelt

Investigators

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Summary

The U.S. Bureau of Reclamation (Reclamation), Tracy Fish Collection Facility (TFCF) is located at the head of the Delta-Mendota Canal (DMC) 4 km northeast of the C.W. "Bill" Jones Pumping Plant (JPP; formerly Tracy Pumping Plant) and 14.5 km northwest of Tracy, California (San Joaquin County). Reclamation's JPP exports up to 130.26 cubic meters per second (cms) of water south for agricultural, municipal and industrial use out of the Sacramento-San Joaquin Delta (Delta; Arthur *et al.* 1996). The TFCF was built in 1956 by Reclamation to remove Chinook salmon (*Oncorhynchus tshawytscha*) and striped bass (*Morone saxatilis*) $\geq$ 20mm FL from the DMC. Once fish are removed from the DMC, they are held in 6.1-m-diameter concrete holding tanks for 8–12 h or until transportation back to the Delta is deemed necessary according to the Bates truck loading tables. The number of fish in the holding tanks and haul-out trucks are estimated using the fish count procedure in which a sub-sample of the water flowing into the tanks is taken every 2 h.

In 2004 and 2005 the fish count procedure was tested for its efficiency in retaining juvenile delta smelt (*Hypomesus transpacificus*). These data were released in 2007 and show that a large percentage of delta smelt 20–30 mm FL are passing through the screen used at the fish count station (Sutphin *et al.* 2007) and are not able to be counted. Consequently, the number of fish entering and accumulating in the holding tank between sub-samples may be larger than our estimated amount which can result in overloading and affect the water quality in the fish-haul truck. From the 2007 study, it was determined that a fish count screen hole size of $\leq$ 2.5 mm in diameter is needed to guarantee a 20-mm FL delta smelt is not lost through the screen holes (Sutphin *et al.* 2007). The current holding tank screen maximum diameter is 4.3 mm (Sutphin *et al.* 2007); therefore loss from the holding tank screens is expected and may be as large as that found at the fish count station screen. The loss of entrained fish through the holding tank screen potentially results in pump mortality and does not allow for the accurate

estimation of the fish loading densities in the fish haul truck by extrapolation of fish count data. Determining which size classes of delta smelt are effectively retained in the holding tank will help us to gain insight on the accuracy of TFCF juvenile smelt salvage data, along with the accuracy of the fish loading densities in the fish haul truck.

One control replicate has been completed for each of the two smallest size classes of juvenile delta smelt in order to demonstrate that our 500-µm net could retain juvenile delta smelt and that the retained delta smelt could be effectively recovered from the net after each repetition. The control replicate demonstrated that the 500-µm net did retain most of the juvenile delta smelt and the fish could be recovered from the net by thoroughly rinsing (90–100%). We proceeded to the Net Verification and Improvement replicates, in an effort to determine the best net modifications and procedures for efficiently collecting the injected juvenile delta smelt.

Initially, during our Net Verification and Improvement replicates, there was no seal on the lip of the sample net frame and the replicates were rinsed using the collect valve in the holding tank. Three Net Verification and Improvement replicates for the two available size classes (10–14.9 and 15–19.9 mm TL) were completed in this manner. During these trials, only 64%, on average, of the injected juvenile delta smelt were recovered in the juvenile fish net. This led us to believe that fish were possibly being lost by going under the net frame and down the drain and/or that rinsing the holding tank with the collect valve was pushing the juvenile delta smelt up the floor of the holding tank and was leaving them stranded. Due to this, we decided to perform the same Net Verification and Improvement procedure with a seal installed on the lip of the sample net frame and without using the collect valve to rinse the tank.

One Net Verification and Improvement replicate for the 10- to14.9-mm TL size class and two Net Verification and Improvement replicates for the 15- to19.9-mm TL size class were completed using a seal and the high pressure hose to rinse the holding tank. Rinsing with the high pressure hose and using the seal drastically increased the percentage of injected juvenile delta smelt that were recovered in our net. On average, 90% of the injected juvenile delta smelt was recovered during these replicates. Due to this, we will complete the holding tank screen efficiency experiments with the seal and will utilize the high pressure hose for all rinsing activity during our holding tank screen efficiency replicates.

Preliminary results of the holding tank screen efficiency experiment suggest that, on average, 27% of the 10- to 14.9-mm TL juvenile delta smelt and 22% of the 15- to 19.9-mm TL juvenile delta smelt are successfully recovered in the juvenile fish net during the 0-min swirl replicates. On average, 20% of the 10- to 14.9-mm TL and 15-to 19.9-mm TL size classes were recovered during the 1-min swirl replicates. Fifteen percent, on average, of the 10- to 14.9-mm TL size class and 13%, on average, of the 15- to 19.9-mm TL size class were recovered in the 5-min swirl replicates, whereas 0% and 6% recovery was observed for the 10- to 14.9 and 15- to 19.9-mm TL size classes, respectively, during the 30-min swirl replicates. Holding tank screen efficiency replicates for the15-min swirl periods have been completed and the samples have been collected. Despite this, the samples have yet to be processed or analyzed and data for the average percent recovery of juvenile delta smelt, during the 15-min swirl period, is not currently available.

All equipment for this study was purchased in 2007 (500-µm net, net frame) although work was not possible due to construction activity at the TFCF. Modifications (collar was added in order to fit net to frame) to the net were made in March 2008. Two new 500-µm nets were ordered and received before the FY 2009 study period.

Problem Statement

The loss of delta smelt between 20 and 30 mm FL through the holding tank screen results in pump mortality as well as inaccurate estimation of the both the number of fish salvaged and the fish loading densities in the fish haul truck. The primary objective of this study is to determine the holding tank screen entrainment efficiency for five size classes (10–14.9, 15–19.9, 20–24.9, 25–29.9 and 30–34.9 mm TL) of juvenile delta smelt during 0-, 1-, 5-, 15- and 30-min swirl periods. Determining which size classes of delta smelt are effectively retained in the holding tank will help us to gain insight on the accuracy of TFCF juvenile smelt salvage data, along with the accuracy of the fish loading densities in the fish haul truck.

Goals and Hypotheses

Goals:

1. Determine the holding tank screen entrainment efficiency for five size classes (10–14.9, 15–19.9, 20–24.9, 25–29.9 and 30–34.9 mm TL) of juvenile delta smelt during 0-, 1-, 5-, 15- and 30-min swirl periods.

2. Develop a probability-capture curve for juvenile delta smelt based on total TL (10–14.9, 15–19.9, 20–24.9, 25–29.9 and 30–34.9 mm) and the amount of time swirled in the holding tanks (0, 1, 5, 15 and 30 min).

Hypotheses:

1. The holding tank screen entrainment efficiency will increase with increasing size of juvenile delta smelt for 0-, 1-, 5-, 15- and 30-min swirl periods.

2. The holding tank screen entrainment efficiency for all size classes will be reduced with increased swirl time.

Materials and Methods

Holding Tank Screen Efficiency Experiment

During the holding tank screen efficiency trials completed in 2008, all measurements of delta smelt were taken at the TFCF after the fish were picked up from the FCCL and transported to the TFCF in 18.9-L black buckets with lids. In 2008, only 50 delta smelt from each of the groups of fish picked up from the FCCL were measured in order to determine the size distribution of the fish in each group. Standard length, fork length, total length and maximum body depth measurements were obtained for the 50 fish out of each group using a 50-mg/L MS-222 solution and a Leica™ $MZ7_5$ stereomicroscope (Leica Microsystems, Bannockburn, Illinois) equipped with a micrometer. These size distributions were then applied to the remaining unmeasured fish in each group in order to estimate the number of each sized fish in each of the different groups. This process allowed us to acquire accurate measurements of the delta smelt, as

well as determine the size distribution of each group, without compromising the condition of the fish used in the holding tank screen efficiency experiment. Two 0-min swirl replicates, one 1-min swirl replicate, two 5-min swirl replicates, one 15-min swirl replicate and one 30-min swirl replicate were completed in this manner.

During the holding tank screen efficiency replicates completed during 2009, all 100 delta smelt that were injected for each replicate were measured. Standard length, fork length, total length and maximum body depth measurements were obtained for the 100 fish that were injected using a 50-mg/L MS-222 solution and a Leica $MZ7_5$ stereomicroscope equipped with a micrometer. This was done in order to determine the exact size distribution of each injection group and prevent problems in data analysis. One 1-min swirl replicate, one 15-min swirl replicate and two 30-min swirl replicates were completed in this manner. For all future holding tank screen efficiency experiments every fish injected into the holding tank will be measured.

Zero-, 1-, 5-, 15- and 30-min samples will be made in TFCF holding tanks during a period of time when there is adequate water temperature (14.6 ^{o}C–17.5 ^{o}C) and no wild delta smelt present. Delta smelt from the FCCL will be held in ambient Delta water prior to insertion. Holding tanks will be backfilled and a known number of cultured delta smelt will be inserted into the holding tank using a water-to-water method in which the 18.9-L black buckets will be lowered with a rope and poured. Holding tank valves will be put into operation to initiate collection and waterflow through the holding tank screen. During the specified collection period, flow will be regulated using holding tank pumps (one or two) to mimic typical flow rates when wild delta smelt are salvaged. Flow rates (cms), tank water depths (m), and temperature (^{o}C) will be recorded. After the collection period, the holding tank will be drained to an approximate depth 0.61 m. Our net and frame will be inserted into the drainage pit using the same hoist intended for the fish count and haul-out buckets. The holding tank "fill" valves will be used to backfill the holding tank until water levels inside and outside of the holding tank screen are equal. This process eliminates the problem of a sudden force of water lifting our net frame and the possible loss of fish. Once equilibrium has been achieved, the holding tank screen will be lifted up and the remaining water sample will be collected in our net. The holding tank will then be rinsed using a high pressure hose and our net will be removed and rinsed into 18.9-L buckets. The samples will then be consolidated into one fine meshed (0.39-mm) dipnet by pouring the contents of each 18.9-L bucket into the dipnet. The sample will then be bathed for 5 min in Rose Bengal for staining. After this, the sample will be thoroughly rinsed and placed into a pyrex dish on a light table. All delta smelt will be picked out of the sample. Standard length, fork length, total length and maximum depth (from the insertion of the first dorsal ray to the insertion of the first anal ray) will be recorded for all delta smelt collected. Bycatch of fish $\geq$ 20 mm will be identified to species and measured (FL). We need approximately 500 fish released at each size/time combination to estimate efficiency within 5% with a power of 0.8. Five replicates of 100 fish each will be completed for each size class of juvenile delta smelt during each of the swirl periods.

Data Analyses

We intend to perform up to five replicates for each size class and swirl time. Logistic regression for binary data will be used to determine if fish size and length of

swirl significantly change the probability of capture. A probability-capture curve, with 95% confidence intervals, will then be developed using the Logit link function for fish size and swirl time. This probability-capture curve will allow us to determine the holding tank screen entrainment efficiency, for the six size classes of juvenile delta smelt, during 0-, 1-, 5-, 15- and 30-min swirl periods. Data analysis will be completed by August 2010.

Coordination and Collaboration

All experiments will be coordinated with the TFCF Fish Diversion Operators (Joel Imai) along with the TFCF Biology staff (Brent Bridges). During data collection it will be necessary to utilize a TFCF holding tank and the bucket hoist. Participation and inclusion of research-related updates will be provided at regularly scheduled Tracy Technical Advisory Team (TTAT) and/or Central Valley Fish Facilities Review Team (CVFFRT) meetings.

Endangered Species Concerns

We will be using larval and juvenile stages of domestically reared delta smelt and have timed the tests so that they do not coincide with periods when wild ESA listed delta smelt are present. However, incidental "take" of ESA listed Chinook salmon and/or steelhead trout (*O. mykiss*) is likely to occur during the tests. If collected, ESA listed Chinook salmon and steelhead trout will be measured and released alive back into the normal salvage operations. All larval and/or juvenile delta smelt that are encountered during testing will not be released alive back into the Delta.

Dissemination of Results (Deliverables and Outcomes)

A Tracy Series Report will be prepared and published upon completion of the study. Updates and presentations of progress will be provided internally and upon request by TTAT and other interagency technical forums. A draft report is tentatively scheduled to be completed by September 2010 and a final draft report will be finished by December 2010.

Literature Cited

Arthur, J.F., M.D. Ball, and S.Y. Baughman. 1996. *Summary of federal and state water project environmental impacts in the San Francisco Bay-Delta Estuary, California*. Pages 445–495 *in* J.T. Hollibaugh, editor. San Francisco Bay: The Ecosystem, Further Investigations into the Natural History of San Francisco Bay and Delta With Reference to the Influence of Man. Pacific Division of the American Association for the Advancement of Science, California Academy of Sciences, San Francisco, California

Sutphin, Z., B. Bridges, B. Baskerville-Bridges, and R. Reyes. 2007. *Evaluation of current and historical 10-minute-count screens at the Tracy Fish Collection Facility, Tracy, California*. Tracy Fish Collection Facility Studies, Volume 31. U.S. Bureau of Reclamation, Mid-Pacific Region and Technical Service Center and University of California, Davis.